PALEONTOLOGICAL EVALUATION REPORT FOR THE HIGHWAY 1 SOQUEL TO MORRISSEY AUXILIARY LANES PROJECT IN SANTA CRUZ COUNTY, CALIFORNIA

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SECTION 1

INTRODUCTION

The purpose of this report is to provide an assessment of potential adverse impacts on scientifically significant paleontological resources (fossils – the remains of prehistoric plants and animals) resulting from earth moving associated with proposed construction of the Highway 1 Soquel to Morrissey Auxiliary Lanes Project (hereinafter Project) in western Santa Cruz County, California. This technical report of findings presents the results of the assessment and makes recommendations for mitigating the potential adverse impacts of earth moving on the known and suspected paleontological resources during Project construction. This paleontological resource impact assessment meets all requirements of the National Environmental Protection Act (NEPA), California Environmental Quality Act (CEQA), and the standard measures for mitigating adverse construction-related environmental impacts on paleontological resources established by the Society of Vertebrate Paleontology (SVP 1995, 1996). This paleontological resources inventory and impact assessment was prepared by Dr. Lanny H. Fisk, PhD PG, a California licensed Professional Geologist (PG) and Senior Paleontologist, and by Stephen Blakely, Field Geologist/Paleontologist and Project Manager, both with PRC. The Highway 1 Soquel to Morrissey Auxiliary Lanes Project proposes to add auxiliary lanes in both directions to Highway 1 (State Route 1) for a distance of approximately 0.7 miles (~1.1 kilometers) between the Soquel Avenue on ramp to the Morrissey Boulevard off ramp in the northbound direction and approximately 0.3 miles (~0.5 kilometers) from about 500 feet north of the La Fonda Avenue overcrossing to the Soquel Avenue off ramp in the southbound direction. The purpose of this Project is to improve traffic conditions for lane-changing and merging movements and to improve pedestrian and bicycle access and safety on Highway 1 between Soquel Avenue and Morrissey Boulevard. Excavations for the proposed Project could potentially affect scientifically important paleontological resources. The purpose of this investigation was to identify any paleontological resources that might be impacted by Project excavations.

SECTION 2

SIGNIFICANCE

Paleontological resources (fossils) are the remains or traces of prehistoric plants and animals. Fossils are important scientific and educational resources because of their use in (1) documenting the presence and evolutionary history of particular groups of now extinct organisms, (2) reconstructing the environments in which these organisms lived, (3) and in determining the relative ages of the strata in which they occur and of the geologic events that resulted in the deposition of the sediments that entombed them.

As defined by the Society of Vertebrate Paleontology (SVP; 1995), a paleontological resource can be significant if:

- It provides important information on the evolutionary trends among organisms, relating living organisms to extinct organisms.
- It provides important information regarding development of biological communities or interaction between botanical and zoological biota.
- It demonstrates unusual circumstances in biotic history.
- It is in short supply and in danger of being depleted or destroyed by the elements, vandalism, or commercial exploitation, and is not found in other geographic localities.

Under CEQA guidelines (PRC 15064.5 [a] [2]), public agencies must treat all historical and cultural resources (including paleontological resources) as significant unless the preponderance of evidence demonstrates that they are <u>not</u> historically or culturally significant.

In common with other environmental disciplines such as archaeology and biology (specifically in regard to listed species), the SVP (1995) considers any fossil specimen significant, unless demonstrated otherwise, and, therefore, protected by environmental statutes. This position is held because fossils are uncommon and only rarely will a fossil locality yield a statistically significant number of specimens representing the same species. In fact, vertebrate fossils are so uncommon that, in most cases, each fossil specimen found will provide additional important information about the characteristics or distribution of the species it represents.

An individual fossil specimen is considered scientifically important if it is:

- Identifiable,
- Complete,
- Well preserved,
- Age diagnostic,
- Useful in paleoenvironmental reconstruction,
- A type or topotypic specimen,
- A member of a rare species,
- A species that is part of a diverse assemblage, and/or
- A skeletal element different from, or a specimen more complete than, those now available for that species.

Identifiable land mammal fossils are considered scientifically important because of their potential use in providing accurate age determinations and paleoenvironmental reconstructions for the sediments in which they occur. Moreover, vertebrate remains are comparatively rare in the fossil record. Although fossil plants are usually considered of lesser importance because they are less helpful in age determination and more abundant, they are actually more sensitive indicators of their environment and, thus, as sedentary organisms, more valuable than mobile animals for paleoenvironmental reconstructions. For marine sediments, invertebrate and marine algal fossils, including microfossils, are scientifically important for the same reasons that land mammal and/or land plant fossils are valuable in terrestrial deposits. The value or importance of different fossil groups varies depending on the age and depositional environment of the stratigraphic unit that contains the fossils.

SVP Categories of Sensitivity.

In its standard guidelines for assessment and mitigation of adverse impacts to paleontological resources, the SVP (1995) established three categories of sensitivity for paleontological resources: high, low, and undetermined.

High Sensitivity. Stratigraphic units in which vertebrate or significant invertebrate fossils or significant suites of plant fossils have been previously found have a high potential to produce additional significant non-renewable fossils and are therefore considered to be highly sensitive. In keeping with the significance criteria of the SVP (1995), all stratigraphic units in which vertebrate fossils have previously been found have high sensitivity. Full-time monitoring is recommended during any Project-related ground disturbance in stratigraphic units with high sensitivity.

Low Sensitivity. Stratigraphic units that are not sedimentary in origin or that have not been known to produce fossils in the past are considered to have low sensitivity. Monitoring is usually not recommended nor needed during Project construction through a stratigraphic unit with low sensitivity.

Undetermined Sensitivity. Stratigraphic units that have not had any previous paleontological resource surveys or any fossil finds are considered to have undetermined sensitivity. After reconnaissance surveys, observation of artificial exposures (such as road cuts) and natural exposures (such as stream banks), and possible subsurface testing (such as augering or trenching), an experienced, professional paleontologist can often determine whether the stratigraphic unit should be categorized as having high or low sensitivity.

Caltrans SER Categories of Sensitivity.

In its Standard Environmental Reference, Caltrans uses a tripartite scale of potential for paleontological resources: high, low, and no potential.

High Potential. Rock units which, based on previous studies, contain or are likely to contain significant vertebrate, significant invertebrate, or significant plant fossils. These units include, but are not limited to, sedimentary formations that contain significant nonrenewable paleontological resources anywhere within their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils. These units may also include some volcanic and low-grade metamorphic rock units. Fossiliferous deposits with very limited geographic extent or an uncommon origin (e.g., tar pits and caves) are given special consideration and ranked as high potential. High potential includes the potential for containing: 1) abundant vertebrate fossils; 2) a few significant fossils (large or small vertebrate, invertebrate, or plant fossils) that may provide new and significant taxonomic, phylogenetic, ecologic, and/or stratigraphic data; 3) areas that may contain datable organic remains older than Recent, including Neotoma (sp.) middens; or 4) areas that may contain unique new vertebrate deposits, traces, and/or trackways. Areas with a high potential for containing significant paleontological resources require monitoring and mitigation.

Low Potential. This category includes sedimentary rock units that: 1) are potentially fossiliferous, but have not yielded significant fossils in the past; 2) have not yet yielded fossils, but possess a potential for containing fossil remains; or 3) contain common and/or widespread invertebrate fossils if the taxonomy, phylogeny, and ecology of the species contained in the rock are well understood. Sedimentary rocks expected to contain vertebrate fossils are not placed in this category because vertebrates are generally rare and found in more localized stratum. Rock units designated as low potential generally do not require monitoring and mitigation. However, as excavation for construction gets underway it is possible that new and unanticipated paleontological resources might be encountered. If this occurs, a Construction Change Order (CCO) must be prepared in order to have a qualified Principal Paleontologist evaluate the resource. If the resource is determined to be significant, monitoring and mitigation is required.

No Potential. Rock units of intrusive igneous origin, most extrusive igneous rocks, and moderately to highly metamorphosed rocks are classified as having no potential for containing significant paleontological resources. For projects encountering only these types of rock units, paleontological resources can generally be eliminated as a concern when the PEAR is prepared and no further action taken.

SECTION 3

LAWS, ORDINANCES, REGULATIONS, AND STANDARDS

Paleontological resources are classified as non-renewable scientific resources and are protected by several federal and state statutes (California State Historic Preservation Office 1983, Marshall 1976, West 1991, Fisk and Spencer 1994, Gastaldo 1999), most notably by the 1906 Federal Antiquities Act and other subsequent federal legislation and policies and by the State of California's environmental regulations (CEQA, Section 15064.5). Professional standards for assessment and mitigation of adverse impacts on paleontological resources have been established by the SVP (1995, 1996). Design, construction, and operation of the proposed Project needs to be conducted in accordance with laws, ordinances, regulations and standards (LORS) applicable to paleontological resources. Therefore, the LORS applicable to paleontological resources are briefly summarized below, together with SVP professional standards.

3.1 Federal LORS

Federal legislative protection for paleontological resources stems from the Antiquities Act of 1906 (Public Law [P. L.] 59-209; 16 United States Code 431 *et seq.*; 34 Stat. 225), which calls for protection of historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federal land. The Antiquities Act of 1906 forbids disturbance of any object of antiquity on federal land without a permit issued by the responsible managing agency. This act also establishes criminal sanctions for unauthorized appropriation or destruction of antiquities. The Federal Highways Act of 1958 specifically extended the Antiquities Act to apply to paleontological resources and authorized the use of funds appropriated under the Federal-Aid Highways Act of 1956 to be used for paleontological salvage in compliance with the Antiquities Act and any applicable state laws (Fisk and Spencer 1994). The language in the Highways Act makes it clear that Congress intended that, to be in compliance with the Antiquities Act, highway construction projects must protect paleontological resources. Federal protection would apply to this Project if it is federally funded through the Federal Highway Administration.

In addition to the Antiquities Act, other Federal statues protecting fossils include the following. The Historic Sites Act of 1935 (P.L. 74-292; 49 Stat. 666, 16 U.S.C. 461 *et seq.*) declares it national policy to preserve objects of historical significance for public use and gives the Secretary of the Interior broad powers to execute this policy, including criminal sanctions. The National Environmental Policy Act of 1969 (P.L. 91-190, 31 Stat. 852, 42 U.S.C. 4321-4327) requires that important natural aspects of our national heritage be considered in assessing the environmental consequences of any proposed project. The Federal Land Policy Management Act of 1976 (P.L. 94-579; 90 Stat. 2743, U.S.C. 1701-1782) requires that public lands be managed in a manner that will protect the quality of their scientific values. Paleontological resources are also afforded federal protection under 40 CFR 1508.27 as a subset of scientific resources.

3.2 State LORS

Guidelines for the Implementation of CEQA, as amended 7 September 2004 (Title 14, Chapter 3, California Code of Regulations: 15000 *et seq*.) define procedures, types of activities, persons, and public agencies required to comply with CEQA, and include as one of the questions to be answered in the Environmental Checklist (Section 15023, Appendix G, Section XIV, Part a) the following: "*Will the proposed project directly or indirectly destroy a unique paleontological resource or site?*"

Although neither CEQA nor the Guidelines define what is "*a unique paleontological resource or site*", CEQA section 21083.2 defines "*unique archaeological resources*" as "…*any archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria*:

1) *contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information*.

2) *it has a special and particular quality such as being the oldest of its type or the best available example of its type*.

3) *is directly associated with a scientifically recognized import prehistoric or historic event*."

With only slight modification, this definition is equally applicable to recognizing "*a unique paleontological resource or site*." Additional guidance is provided in CEQA Guidelines section 15064.5(a)(3)(D), which indicates "*generally, a resource shall be considered historically significant if it has yielded, or may be likely to yield, information important in prehistory or history*."

CEQA Guidelines section XVII, Part a, of the Environmental Checklist asks a second question equally applicable to paleontological resources: "*Does the project have the potential to . . . eliminate important examples of the major periods of California history or pre-history*?" Fossils are important examples of the major periods of California prehistory. To be in compliance with CEQA, environmental impact assessments, statements, and reports must answer both these questions in the Environmental Checklist. If the answer to either question is yes or possibly, a mitigation and monitoring plan must be designed and implemented to protect significant paleontological resources.

The CEQA lead agency having jurisdiction over a project is responsible to ensure that paleontological resources are protected in compliance with CEQA and other applicable statutes. Caltrans is the CEQA lead agency with the responsibility to ensure that fossils are protected during construction on this Project. California Public Resources Code section 21081.6, entitled Mitigation Monitoring Compliance and Reporting, requires that the lead agency demonstrate project compliance with mitigation measures developed during the environmental impact review process.

Other state requirements for paleontological resource management are in California Public Resources Code Chapter 1.7, Section 5097.5 (Stats. 1965, c. 1136, p. 2792), entitled Archaeological, Paleontological, and Historical Sites. This statute defines any unauthorized disturbance or removal of a fossil site or fossil remains on public land as a misdemeanor and specifies that state agencies may undertake surveys, excavations, or other operations as necessary on publicly owned lands to preserve or record paleontological resources. This statute applies to this Project because impacts will occur on California state-owned lands.

3.3 County and City LORS

California Planning and Zoning Law requires each county and city to adopt a comprehensive, long-term general plan for its physical development. The general plan is a policy document designed to give long range guidance to those making decisions affecting the future character of the planning area. It represents the official statement of the community's physical development as well as its environmental goals. The general plan also acts to clarify and articulate the relationship and intentions of local government to the rights and expectations of the general public, property owners, and prospective investors. Through its general plan, each county and city informs these groups of its goals, objectives, policies, and development standards; thereby communicating what must be done to meet the objectives of the general plan. State planning law also requires each county and city to identify environmental resources and to prepare and implement policies and programs which relate to the utilization and management of these resources.

The Conservation and Open Space Element of the Santa Cruz County General Plan adopted in 1994 contains reference to the significance and protection of paleontological resources. The section entitled "*Hydrological, Geological, and Paleontological Resources*" on page 5-31 includes Objective 5.9: "*To protect . . . paleontological resources which stand out as rare or unique and representative in Santa Cruz County because of their scarcity, scientific or educational value, aesthetic quality or cultural significance.*" In that same section of the General Plan, Policy 5.9.1 states: "*Protect significant . . . paleontological features, through the environmental review process.*"

The City of Santa Cruz General Plan 1990-2005 in the Cultural Resources Element states as Goal CR1: "*Ensure the protection and proper disposition of archaeological and paleontological sites to preserve resources important to the community's heritage.*" To anticipate the presence of paleontological resources, consultants to the City of Santa Cruz developed a very generalized paleontological sensitivity map to show paleontologically sensitive areas. The only area shown on the map to be paleontologically sensitive was the beach cliffs in the vicinity of Lighthouse Point. The City General Plan lists the following policies and programs dealing with paleontological resources:

1) "*Identify sensitive archaeological and paleontological sites early in land-use planning and/or development process so archaeological and paleontological resources can be given consideration during the conceptual design phase of private or public projects.*"

2) "*Develop a mitigation plan for proper site disposition prior to approval of any project that may adversely impact a paleontological site.*"

3) "*Protect archaeological and paleontological resources after project approval by providing for the evaluation and proper disposition of the resources discovered in the course of a project.*"

3.4 Professional Standards

The SVP, a national scientific organization of professional vertebrate paleontologists, has established standard guidelines (SVP 1991, 1995, 1996) that outline acceptable professional practices in the conduct of paleontological resource assessments and surveys, monitoring and mitigation, data and fossil salvage, sampling procedures, and specimen preparation, identification, analysis, and curation. Most practicing professional paleontologists in the nation adhere closely to the SVP's assessment, mitigation, and monitoring requirements as specifically spelled out in its standard guidelines. The SVP's standard guidelines were approved by a consensus of professional paleontologists and are the standard against which all paleontological monitoring and mitigation programs are judged. Many federal and state regulatory agencies have either formally or informally adopted the SVP's "standard guidelines" for the mitigation of construction-related adverse impacts on paleontological resources, including both federal (FERC, USFS, BLM, NPS, etc.) and state agencies (CEC, CPUC, Caltrans, etc.).

Briefly, SVP guidelines require that each project have literature and museum archival reviews, a field survey, and, if there is a high potential for disturbing significant fossils during project construction, a mitigation plan that includes monitoring by a qualified paleontologist to salvage fossils encountered, identification of salvaged fossils, determination of their significance, and placement of curated fossil specimens into a permanent public museum collection (such as the designated California State repository for fossils, the University of California Museum of Paleontology [UCMP] at Berkeley).

SECTION 4

AFFECTED ENVIRONMENT

4.1 Geographic Location

The proposed Project is located along the north shore of Monterey Bay in southwestern Santa Cruz County, California, within or near the City of Santa Cruz. In this report, this area is sometimes referred to as the Santa Cruz vicinity. Highway improvements along Highway 1 are planned for a distance of approximately 0.7 miles (~1.1 kilometers) between the Soquel Avenue on ramp to the Morrissey Boulevard off ramp in the northbound direction and approximately 0.3 miles (~0.5 kilometers) from about 500 feet north of the La Fonda Avenue overcrossing to the Soquel Avenue off ramp in the southbound direction (Figure 1). The ground surface in the Project vicinity is rolling hills with relatively flat coastal terraces. Sea cliffs as much as 100 feet high border the lower, most extensive terrace. The sea cliffs have at their base narrow beaches composing the shoreline of Monterey Bay. Along the section of Highway 1 to be improved, elevation varies between approximately 40 and 100 feet (~12-30 meters). The location is within the southwestern foothills of the Santa Cruz Mountains, the westernmost range in the central Coast Ranges. The Coast Ranges Physiographic Province is located between the Central Valley Physiographic Province on the east and the Pacific Ocean on the west. The Project right-of-way is located primarily within the U. S. Geological Survey (USGS) Soquel 7.5-minute (1:24,000-scale) Quadrangle but extends into the eastern edge of the Santa Cruz 7.5-minute (1:24,000-scale) Quadrangle.

4.2 Regional Geologic Setting

The geology in the vicinity of the proposed Project has been mapped or described by numerous workers, including Ashley (1895), Arnold (1908), Branner and others (1909), Arnold and Hannibal (1913), Hubbard (1943), Clark (1966), Akers and Hickey (1967), and Greene (1977). Surficial geologic mapping of the Project vicinity has been provided at a scale of 1:750,000 by Jennings (1977); at a scale of 1:500,000 by Jenkins (1938); at a scale of 1:250,000 Jennings and Strand (1958), McCrory and others (1977), and Chin and others (1993); at a scale of 1:125,000 by Branner and others (1909), Clark (1970), Clark and Rietman (1973), and Greene (1977); at a scale of 1:100,000 by Wagner and others (2002); at a scale of 1:62,500 by Brabb (1986, 1989, 1997); and at a scale of 1:48,000 by Akers and Hickey (1967). No 1:24,000 or larger scale geologic maps are available for the Project area. The information in these published geologic maps and reports forms the basis of the following discussion. Individual maps and publications are incorporated into this report and referenced where appropriate. The aspects of geology pertinent to this report are the types, distribution, and age of sediments immediately underlying the Project right-of-way and their probability of producing fossils during Project construction. The site-specific geology in the vicinity of the Project is discussed separately below.

The area in the vicinity of Santa Cruz is underlain by marine and continental sedimentary deposits of Tertiary and Quaternary age. Potentially fossiliferous rocks include strata ranging in age from Tertiary Miocene (Santa Margarita Sandstone and Santa Cruz Mudstone) to Holocene alluvial deposits. These strata dip gently toward the southeast away from the uplifted granite and metamorphic rocks composing Ben Lomond Mountain. The older stratigraphic units (Santa Margarita Sandstone and Santa Cruz Mudstone), as well as the Plio-Pleistocene Aromas Sand, are not exposed within the Project right-of-way and in all probability will not be impacted by

Project excavations. Consequently, these formations will not be considered further in this report. The Pliocene through Quaternary strata that will be impacted by Project construction are described below.

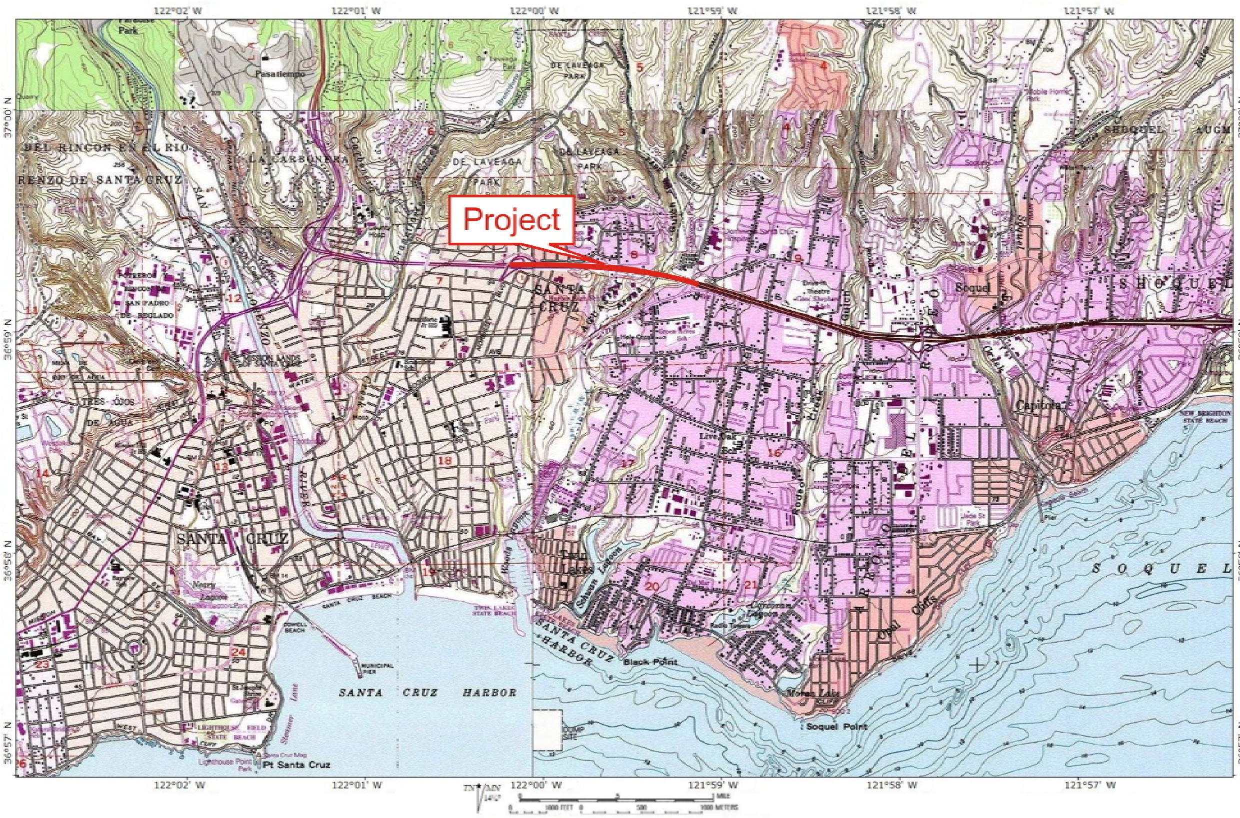

Figure 1. Map of the Project area (approximately 1:62,500-scale) in Santa Cruz County with the approximate extent of the proposed Project along Highway 1 added in red. Modified from USGS Santa Cruz, Soquel, Felton, and Laurel 7.5-minute (1:24,000-scale) Quadrangles.

4.3 Resource Inventory Methods

To develop a baseline paleontological resource inventory of the Project vicinity and to assess the potential paleontological productivity of each stratigraphic unit present along the Highway 1 right-of-way, the published as well as available unpublished geological and paleontological literature was reviewed; and stratigraphic and paleontologic inventories were compiled, synthesized, and evaluated (see below). These methods are consistent with SVP (1995) guidelines for assessing the importance of paleontological resources in areas of potential environmental impact. No subsurface exploration was conducted for this assessment.

Geologic maps and reports covering the bedrock and surficial geology of the Project vicinity were reviewed to determine the exposed and subsurface rock units, to assess the potential paleontological productivity of each rock unit, and to delineate their respective areal distribution in the Project area. In addition, available aerial photographs of the area were examined to aid in determining the areal distribution of distinctive sediment and soil types.

The number and locations of previously recorded fossil sites from rock units exposed in and near the proposed Project right-of-way and the types of fossil remains each rock unit has produced were evaluated based on published and unpublished geological and paleontological literature. The literature review was supplemented by archival records searches at the University of California Museum of Paleontology (UCMP) in Berkeley and at the Santa Cruz Museum of Natural History (SCMNH) in Santa Cruz, looking for additional information regarding the occurrence of fossil sites and remains on and near the Project right-of-way. Paleontologist Mr. Frank Perry was most gracious in compiling the SCMNH fossil localities in the Project vicinity and providing that information. Mr. Perry also referenced several fossil localities collected by the California Academy of Sciences (CAS) and the Los Angeles County Museum of Natural History (LACM). In addition, the compilation of USGS paleontological localities published by Powell (1998) was very helpful.

A field survey, which included visual inspection of exposures of both fossiliferous and potentially fossiliferous strata in the Project area, was conducted to document the presence of sediments suitable for containing fossil remains and the presence of any previously unrecorded fossil sites. The field survey for this assessment was conducted 10-12 April 2007 by Dr. Lanny H. Fisk, PhD PG, Senior Paleontologist with PRC. During the field survey, stratigraphy was observed in coastal cliff exposures, numerous stream and road cuts, and in excavations at construction sites.

4.4 Paleontological Resource Assessment Criteria

Under SVP (1995) criteria, a stratigraphic unit (such as a formation, member, or bed) known to contain significant fossils is considered to be "sensitive" to adverse impacts if there is a probability that earth-moving or ground-disturbing activities in that rock unit will either disturb or destroy fossil remains. This definition of sensitivity differs fundamentally from that for archaeological resources:

> "*It is extremely important to distinguish between archaeological and paleontological (fossil) resource sites when defining the sensitivity of rock units. The boundaries of archaeological sites define the areal extent of the resource. Paleontologic sites, however, indicate that the containing sedimentary rock unit or formation is fossiliferous. The limits of the entire rock formation, both areal and stratigraphic, therefore define the scope of the paleontologic potential in each case*" (SVP 1995).

This distinction between archaeological and paleontological sites is important. Most archaeological sites have a surface expression that allows for their geographic location. Fossils, on the other hand, are an integral component of the rock unit below the ground surface, and, therefore, are not observable unless exposed by erosion or human activity. Thus, a paleontologist cannot know either the quality or quantity of fossils present before the rock unit is exposed as a result of natural erosion processes or earth-moving activities. The paleontologist can make conclusions on sensitivity to impact based only upon what fossils have been found in the rock unit in the past, along with a judgment on whether or not the depositional environment of the sediments that compose the rock unit was likely to result in the burial and preservation of fossils.

Fossils are seldom uniformly distributed within a rock unit. Most of a rock unit may lack fossils, but at other locations within the same rock unit concentrations of fossils may exist. Even within a fossiliferous portion of the rock unit, fossils may occur in local concentrations. For example, Shipman (1977, 1981) excavated a fossiliferous site using a three dimensional grid and removed blocks of matrix of a consistent size. The site chosen was known prior to excavation to be richly fossiliferous, yet only 17% of the excavated blocks actually contained fossils. These studies demonstrate the physical basis for the difficulty in predicting the location and quantity of fossils in advance of actual project-related ground disturbance.

Since it is not possible to determine where fossils are located prior to actually disturbing a rock unit, monitoring of excavations by an experienced paleontologist during construction increases the probability that fossils will be discovered and preserved. Preconstruction mitigation measures such as surface prospecting and collecting will not prevent adverse impacts on fossils because many sites will be unknown in advance due to an absence of fossils at the surface.

The non-uniform distribution of fossils within a rock unit is essentially universal and many paleontological resource assessment and mitigation reports conducted in support of environmental impact documents and mitigation plan summary reports document similar findings (see for instance Lander 1989, 1993; Reynolds 1987, 1990; Spencer 1990; Fisk and others 1994; and references cited therein). In fact, most fossil sites recorded in reports of impact mitigation (where construction monitoring has been implemented) had no previous surface expression. Because the presence or location of fossils within a rock unit cannot be known without exposure resulting from erosion or excavation, under SVP (1995) standard guidelines, an entire rock unit is assigned the same level of sensitivity based on recorded fossil occurrences.

Using SVP (1995) criteria, the paleontological importance or sensitivity (high, low, or undetermined) of a rock unit is the measure most amenable to assessing the significance of paleontological resources because the areal distribution of that rock unit can be delineated on a topographic or geologic map. The paleontological importance of a stratigraphic unit reflects: (1) its potential paleontological productivity (and thus sensitivity), and (2) the scientific significance of the fossils it has produced. This method of paleontological resource assessment is the most appropriate because discrete levels of paleontological importance can be delineated on a topographic or geologic map.

The potential paleontological productivity of a stratigraphic unit exposed in a project area is based on the abundance/densities of fossil specimens and/or previously recorded fossil sites in exposures of the unit in and near a project site. The underlying assumption of this assessment method is that exposures of a stratigraphic unit in a project site are most likely to yield fossil remains both in quantity and density similar to those previously recorded from that stratigraphic unit in and near the project site.

The following tasks were completed to establish the paleontological importance and sensitivity of each stratigraphic unit exposed in or near the Project site:

- The potential paleontological productivity of each rock unit was assessed based on previously recorded and newly documented fossil sites it contains at and/or near the Project site.
- The scientific importance of fossil remains recorded from a stratigraphic unit exposed at and/or near the Project site was assessed.
- The paleontological importance of a rock unit was assessed, based on its documented and/or potential fossil content in the area surrounding the Project site.

SECTION 5

RESULTS

5.1 Stratigraphic Inventory

Regional geologic mapping that includes all or part of the proposed Project right-of-way has been published by Jennings (1977; 1:750,000); Jenkins (1938; 1:500,000 scale), Branner and others (1909; 1:250,000 scale), Jennings and Strand (1958; 1:250,000 scale), McCrory and others (1977; 1:250,000 scale), Clark (1970; 1:125,000 scale), Clark and Rietman (1973; 1:125,000 scale), and Wagner and others (2002; 1:100,000 scale). Larger scale mapping of the Project area has been provided by Dupré (1975; 1:62,500 scale), Brabb (1986, 1989, 1997; 1:62,500 scale), and Akers and Hickey (1967; 1:48,000 scale). These geologic maps were reviewed to determine the stratigraphic units that might be impacted by Project-related excavations. During the field survey for this Project, this geologic mapping was "ground truthed" and determined to be reasonably accurate, given the limited exposures and vegetation cover.

5.2 Project Geology

In the most recent large-scale geologic mapping available of the Project site, Brabb (1997; 1:62,500 scale; see Figure 2) mapped the following stratigraphic units along the section of Highway 1 to be improved by this Project (listed from oldest to youngest): Pliocene Purisima Formation, Pleistocene terrace deposits, and Quaternary alluvium. Each of these stratigraphic units will be discussed separately below.

Purisima Formation. The Pliocene Purisima Formation was named by Haehl and Arnold (1904) for exposures near Purisima and along Purisima Creek in the northern Santa Cruz Mountains, San Mateo County. This formation is the most widespread stratigraphic unit along the Pacific Coast of central California and underlies most of the Santa Cruz-Aptos area. In this area it is almost continuously exposed in sea cliffs up to 100 feet high and is also exposed in deep canyons in the foothills above the urbanized terraces. Based upon recent published geologic mapping (Brabb 1997) and available borehole log data from Caltrans, the Purisima Formation underlies the Project right-of-way at a depth ranging from surface exposure to approximately four feet (~1.2 meters).

The Purisima Formation is composed of weakly cemented, interbedded conglomerate, sandstone, siltstone, claystone, and shell coquina (Figures 3 and 4). Locally it is siliceous, tuffaceous, and/or diatomaceous (Cummings and others 1962, Nilsen and Brabb 1979, personal observations). The most abundant and characteristic rock exposed in sea cliffs in the Santa Cruz vicinity is dark olive drab to slate gray argillaceous (muddy) sandstone. Some of the sandstone beds contain so many fossil mollusk shells that they are a true coquina. Locally coquina beds and less fossiliferous sandstones and conglomerates are well cemented and resistant to erosion. The sandstone is composed largely of fine to medium, fairly well-sorted grains of primarily volcanic clasts of basaltic or andesitic composition (Akers and Hickey 1967). Interbedded tuffaceous siltstones and diatomaceous shales are also locally highly fossiliferous, but typically not well cemented and easily eroded. Some parts of the Purisima are extensively bioturbated (Perry 1977, 1988, 1993; Nilsen and Brabb 1979). The basal sandstone of the Purisima Formation has yielded a radiometric date of 6.7 ± 0.5 million years (Obradovich in Clark 1966), suggesting a latest Miocene age for the lowermost part of the formation, in agreement with the biostratigraphic age based on diatoms (Addicott 1966, Clark and others 1979). However, most of the Purisima appears to be Pliocene in age based on both invertebrate and vertebrate fossils.

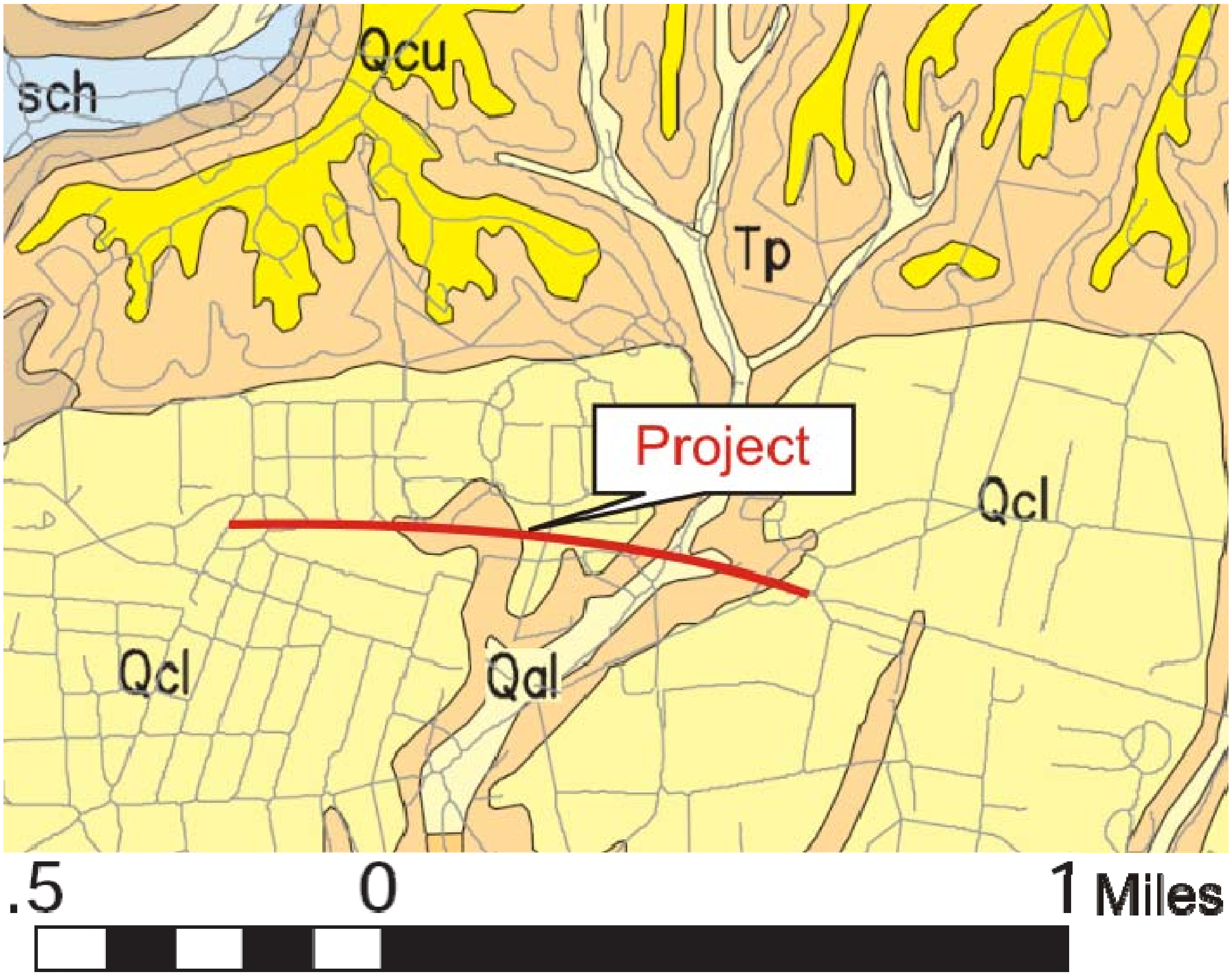

Figure 2. Geologic map of the Project vicinity showing the primary stratigraphic units exposed on the Project right-of-way as Tp (Tertiary Purisima Formation), Qcl (Quaternary terrace deposits), and Qal (Quaternary alluvium). Map modified from Brabb (1997).

Figure 3. Photograph of cliff exposure of Purisima Formation sandstones in the northern portion of Seacliff State Beach in Aptos, east of the Project right-of-way. Photograph was taken on 11 April 2007.

Figure 4. Photograph of highly fossiliferous sandstone of the Purisima Formation exposed in the northern portion of Seacliff State Beach in Aptos, east of the Project right-of-way. Photograph was taken on 11 April 2007.

Pleistocene Terrace Deposits. In this stratigraphic unit we include sediments deposited on both wave-cut and stream terraces, as have other geologists working in the area (Ashley 1895, Arnold 1908, Akers and Hickey 1967). Pleistocene terrace deposits unconformably overlie the Purisima Formation and in the Santa Cruz area form extensive coastal deposits (Jack 1969). The terraces are very prominent in the Santa Cruz area, where they have been studied in detail by Bradley (1956, 1957) and Bradley and Griggs (1976). The youngest marine terrace, at about 100 feet above sea level, is Sangamon in age or about 90,000 to 120,000 radiocarbon years old (Lajoie and others 1972).

Pleistocene terrace deposits in the Santa Cruz area extend from the edge of the foothills to near sea-level with a very gentle slope (Ashley 1895). Each terrace has a sea cliff, from the foot of which the ground surface slopes gently to the top of the next lower sea cliff. Sediments deposited on these terraces may be up to 200 feet thick (Brabb 1997) but thickness is highly variable and more typically only a few feet thick (Akers and Hickey 1967). In the vicinity of the Project right-of-way, Caltrans borehole logs indicate that the Pleistocene terrace deposits are up to approximately four (4) feet thick. These deposits consist of weakly consolidated to semi-consolidated, generally well-sorted, fine- to medium-grained sand with a few thin, discontinuous layers of silt and pebble to cobble gravel. At the base of the deposits, resting directly on the eroded wave-cut marine terrace, are marine deposits of sand and gravel, which grade upward into fluvial (stream deposited) silt, sand, and gravel with some eolian (wind-blown) sand. The wave-cut terraces represent ancient shorelines.

Quaternary Alluvium. This stratigraphic unit was simply referred to as Quaternary "alluvial deposits" by Brabb (1986, 1989, 1997), who applied this name to gravel, sand, silt, and clay deposited along the channels of modern streams and on their flood plains. In the immediate Project vicinity, this stratigraphic unit was mapped by Brabb (1986, 1989, 1997) as being present only along Arana Gulch (Figure 2). Isolated deposits of Holocene alluvium, too small to appear on a 1:62,500-scale geologic map, undoubtedly exist at other locations elsewhere along the Project right-of-way. During the field survey for this Project, unmapped deposits of Holocene alluvium a few inches to a few feet thick were exposed at several locations along Highway 1, where they overlie semi-consolidated brown to brownish-gray sand and gravel terrace deposits or tan to light-brown diatomaceous sediments of the Purisima Formation.

5.3 Paleontological Resource Inventory

An inventory of known paleontological resources previously discovered in the vicinity of the proposed Project is presented below and the paleontological importance of these resources is assessed. The literature review and museum archival search conducted for this inventory documented no previously recorded fossil sites within the actual Project right-of-way. However, rocks and/or sediments of the Purisima Formation and Pleistocene Terrace Deposits have yielded fossilized remains of extinct species at numerous previously recorded fossil sites in the Santa Cruz area (see discussion below). In addition, fossil remains were found at several previously unrecorded fossil sites during the field survey of the proposed Project right-of-way and vicinity conducted for this assessment.

Purisima Formation. The Purisima Formation has yielded a rich fossil record of invertebrates (snails, clams, sand dollars, crabs), vertebrates (fish, both marine and terrestrial mammals, birds), plants (wood, cones, and other plant remains [Ashley 1895]), microfossils (foraminifera

[Goodwin and Thomson 1954] and diatoms [Clark and others 1979]), and ichnofossils (burrows [Perry 1977]). In one of the earliest descriptions of Purisima sediments, Ashley (1895) wrote that "the beds here are very fossiliferous and the fossils generally fairly well preserved." In addition to the abundance of invertebrate fossils, the Purisima has yielded several significant specimens of seals (Mitchell 1962, Barnes 1971, Repenning and Tedford 1977) and whales (Barnes 1976).

In a written personal communication on 16 April 2007, Mr. Frank Perry, curator of the SCMNH, described the Purisima Formation as "very fossiliferous as revealed by outcrops along the coastal cliffs and inland in the vicinity of Soquel, Cabrillo College, and Nisene Marks State Park. Although there are not many natural exposures between the coastal beds and those inland, it seems safe to assume that the fossiliferous strata are continuous between the two. The Purisima Formation contains a variety of marine invertebrate and vertebrate fossils. Occasionally it has produced terrestrial plants and mammals" The SCMNH collections include marine invertebrate and vertebrate fossils, as well as nonmarine terrestrial plants and mammals. UCMP collections also include numerous fossil localities within Purisima Formation sediments in Santa Cruz County. During the field survey of prospective fossiliferous sediments in the Project vicinity on 10-12 April 2007, abundant invertebrate fossils, fossil leaves, and ichnofossils (burrow and root casts and molds) were found in Purisima Formation sediments at several localities (Figures 5 and 6, for locations see confidential map in Appendix C). The abundance of fossils previously reported from the Purisima Formation and observed in exposures in the vicinity of the Project right-of-way during the field survey for this assessment clearly indicate that this stratigraphic unit has a high sensitivity to impacts resulting from ground disturbance. As the available recent geologic mapping (Brabb 1997) and borehole log data from Caltrans indicates that the Purisima Formation lies at or just below the ground surface within the Project right-of-way, there is a high potential for adverse impacts on paleontological resources resulting from ground disturbance during Project excavations in sediments of the Purisima Formation.

Pleistocene Terrace Deposits. Fossils are not common in the Pleistocene terrace deposits, based on previous published reports and museum records of fossils from this stratigraphic unit. Ashley (1895) wrote that: "Fossils are not abundant in the Quaternary along the [central California] coast, though at places *Haliotis* [abalone] and some other shells are quite plentiful." From Pleistocene terrace deposits Ashley also reported "fragments of wood and cones of a conifer", "trunks of spruce and redwood", and "a number of horizontal pines." Ashley (1895) also wrote that the Pliocene strata are "overlaid by horizontal or nearly horizontal strata containing *Elephas* [mammoth or mastodon] bones." Arnold (1908) also wrote that the Pleistocene terrace deposits near the lighthouse at Santa Cruz yielded a "considerable fauna."

Both Pleistocene marine and river terrace deposits in the Santa Cruz area have yielded marine invertebrates, vertebrates, and microfossils (foraminifera, Addicott 1966). The SCMNH has both horse and cetacean (whale) fossils, along with a large collection of invertebrate fossils from marine terrace deposits just above the contact with the underlying Purisima Formation. CAS also has a collection of these Pleistocene fossils. SCMNH also has Pleistocene mastodon remains from a river terrace along Aptos Creek. During the field survey for this assessment, a paleosol containing ichnofossils was observed in terrace deposits located within the Project right-of-way at the Morrissey entrance to Highway 1. Although ichnofossils by themselves may not qualify as sensitive paleontological resources, they indicate the presence of a paleosol (fossil soil) representing a living surface upon which one would expect to find other types of fossils.

Thus, the presence of ichnofossils is an indication that other, more significant fossils might be found at that stratigraphic horizon. Since significant fossils have been previously reported from Pleistocene terrace deposits in the vicinity of the Project right-of-way, and since exposures of terrace deposits within the right-of-way exhibited conditions favorable for the preservation of fossils, based upon Caltrans SER criteria, this stratigraphic unit is judged to have high potential. Any additional fossils discovered in this stratigraphic unit during Project excavations could be highly significant.

Figure 5. Fossil shell coquina layers in the Purisima Formation exposed in the northern portion of Seacliff State Beach in Aptos, east of the Project right-of-way. Photograph was taken on 11 April 2007.

Figure 6. Bedding plane view of fossil shell coquina layer in the Pliocene Purisima Formation. Photograph was taken on 11 April 2007 south of the Project right-of-way.

Quaternary Alluvium. During the geological and paleontological literature review and museum archival records searches for this paleontological resource impact assessment, no previously recorded fossil sites were found in Quaternary alluvium in the Santa Cruz vicinity. During the field survey of prospective fossiliferous sediments, no indications were found that the Quaternary alluvium might be fossiliferous. Therefore, because the Quaternary alluvium has not been known to produce fossils in the past, this stratigraphic unit is considered to have low sensitivity/potential.

Summary. Although significant fossils are not known to directly underlie the proposed Project right-of-way, numerous fossil localities have been reported in both the published scientific literature and museum records from the stratigraphic units that underlie the Project site (Brabb 1997) and could be impacted by the Project. The presence of fossils in the Pliocene Purisima Formation and Pleistocene terrace deposits suggests that there is a high potential for additional similar fossil remains to be uncovered by excavations in these stratigraphic units during Project construction. Under SVP (1995) criteria, both of these units have a high sensitivity for producing additional paleontological resources. Additionally, using the tripartite scale as described in the Caltrans SER (Volume 1, Chapter 8), these stratigraphic units would receive a High Potential rating, for the same reasons stated above. Identifiable fossil remains salvaged from either of these stratigraphic units during Project construction could be scientifically important and significant. Because the Quaternary alluvium has not been known to produce fossils in the past, this stratigraphic unit is considered to have low sensitivity/potential. Neither the Plio-Pliocene Aromas Sand nor the Miocene stratigraphic units (Santa Margarita Sandstone and Santa Cruz Mudstone) are present in the immediate Project area (Brabb 1997). Thus, it is highly unlikely that fossils within these stratigraphic units will be impacted by Project construction.

Identifiable fossil remains discovered during Project construction could represent new taxa or new fossil records for the Santa Cruz area or for the State of California. They could also represent geographic or temporal range extensions. Moreover, additional fossil remains could make it possible to more accurately determine the age, paleoclimate, and/or depositional environment of the sediments from which they are discovered. Finally, fossil remains salvaged during Project construction could provide a more comprehensive documentation of the diversity of animal and plant life that once existed in Santa Cruz County and could result in a more accurate reconstruction of the geologic and paleobiologic history of the central California coast and Monterey Bay during late Tertiary and Quaternary time.

SECTION 6

ENVIRONMENTAL CONSEQUENCES

6.1 Potential Impacts from Project Construction

Potential impacts on paleontological resources resulting from construction of the proposed Project would primarily involve terrain modification (excavations and drainage diversion measures). Paleontological resources, including an undetermined number of fossil remains and unrecorded fossil sites; associated specimen data and corresponding geologic and geographic site data; and the fossil-bearing strata, could be adversely impacted by ground disturbance and earth moving associated with construction of the Project. Impacts could result from vegetation clearing, grading, widening of road cuts, excavations for bridge foundations, and any other earth-moving activities that would disturb or bury previously undisturbed fossiliferous sediments, making those sediments and their paleontological resources unavailable for future scientific investigation.

The planned clearing, grading, and deeper excavation along the Soquel to Morrissey Auxiliary Lanes Project right-of-way could result in significant adverse impacts to paleontological resources. In addition, the construction of supporting facilities, such as temporary construction offices, laydown areas, and parking areas, would have potential to cause adverse impacts on significant paleontological resources, if they will involve new ground disturbance. Thus, any Project-related ground disturbance could have adverse impacts on significant paleontological resources. However, with a properly designed and implemented mitigation program, these impacts could be reduced to less than significant as required by CEQA.

6.2 Cumulative Impacts

If the Project were to encounter paleontological resources during construction, the potential cumulative effect could be significant, particularly because many past construction projects in the area have not included mitigation for impacts to paleontological resources. However, with a properly designed and implemented mitigation program, the impacts from this Project would be reduced to less than significant and therefore would not add to the cumulative effect. The mitigation measures proposed below would effectively salvage the scientific value of any significant fossils uncovered.

SECTION 7

MITIGATION MEASURES

This section describes proposed mitigation measures that could be implemented to reduce potential adverse impacts to significant paleontological resources resulting from Project construction. Mitigation measures are necessary because of potential adverse impacts of Project construction on significant paleontological resources within the Pliocene Purisima Formation and Pleistocene terrace deposits. The proposed paleontological resource impact mitigation program would reduce to an insignificant level the direct, indirect, and cumulative adverse environmental impacts on paleontological resources that could result from Project construction. The mitigation measures proposed below are consistent with SVP standard guidelines for mitigating adverse construction-related impacts on paleontological resources (SVP 1995, 1996).

Prior to construction, a qualified paleontologist should be retained to both design a monitoring and mitigation program and implement the program during all Project-related ground disturbance. The paleontological resource monitoring and mitigation program should include preconstruction coordination; construction monitoring; emergency discovery procedures; sampling and data recovery, if needed; preparation, identification, and analysis of the significance of fossil specimens salvaged, if any; museum storage of any specimens and data recovered; and reporting. Prior to the start of construction, the paleontologist should conduct a detailed field survey of each exposure of sensitive stratigraphic units within the right-of-way that will be disturbed. Earth-moving construction activities should be monitored wherever these activities have the potential to disturb previously undisturbed strata with high sensitivity/potential. Monitoring will not need to be conducted in areas where sediments have been previously disturbed or in areas where exposed sediments will be buried, but not otherwise disturbed.

Prior to the start of construction, project managers and all construction personnel involved with earth-moving activities should be informed that fossils could be discovered during excavating, that these fossils are protected by laws, on the appearance of typical fossils that might be discovered in the area, and on proper notification procedures. This worker training should be prepared and presented by a qualified paleontologist.

Implementation of these mitigation measures will reduce the potentially significant adverse environmental impact of Project-related ground disturbance and earth-moving on paleontological resources to an insignificant level as required by CEQA by allowing for the salvage of fossil remains and associated specimen data and corresponding geologic and geographic site data that otherwise might be lost to earth-moving and to unauthorized fossil collecting. With a well designed and implemented paleontological resource impact mitigation plan, Project construction could actually result in beneficial impacts on paleontological resources through the discovery of fossil remains that would not have been discovered without Project construction and, therefore, would not have been available for scientific study. The salvage of such fossil remains as part of Project construction could help answer important questions regarding the geographic distribution, stratigraphic position, and age of fossiliferous sediments in the Project area.

SECTION 8

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APPENDIX A

ASSESSMENT AND MITIGATION OF ADVERSE IMPACTS TO NONRENEWABLE PALEONTOLOGICAL RESOURCES -- STANDARD GUIDELINES

ASSESSMENT AND MITIGATION OF ADVERSE IMPACTS TO NONRENEWABLE PALEONTOLOGIC RESOURCES: STANDARD GUIDELINES

Society of Vertebrate Paleontology
Conformable Impact Mitigation Guidelines Committee
Robert E. Reynolds, Chairman

Society of Vertebrate Paleontology News Bulletin Number 163, pages 22-27

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INTRODUCTION

Vertebrate fossils are significant nonrenewable paleontological resources that are afforded protection by federal, state, and local environmental laws and guidelines. The potential for destruction or degradation by construction impacts to paleontologic resources on public lands (federal, state, county, or municipal) and land selected for development under the jurisdiction of various governmental planning agencies is recognized. Protection of paleontologic resources includes: (a) assessment of the potential for property to contain significant nonrenewable paleontologic resources which might be directly or indirectly impacted, damaged, or destroyed by development, and (b) formulation and implementation of measures to mitigate adverse impacts, including permanent preservation of the site and/or permanent preservation of salvaged materials in established institutions. Decisions regarding the intensity of the Paleontological Resource Impact Mitigation Program (PRIMP) will be made by the Project Paleontologist on the basis of the paleontologic resources, not on the ability of an applicant to fund the project.

ASSESSMENT OF THE PALEONTOLOGICAL POTENTIAL OF ROCK UNITS

Sedimentary rock units may be described as having (a) high (or unknown) potential for containing significant nonrenewable paleontologic resources, (b) low potential for containing nonrenewable paleontologic resources or (c) undetermined potential.

It is extremely important to distinguish between archaeological and paleontological (fossil) resource sites when defining the sensitivity of rock units. The boundaries of archaeological sites define the areal extent of the resource. Paleontologic sites, however, indicate that the containing sedimentary rock unit or formation is fossiliferous. The limits of the entire rock formation, both areal and stratigraphic, therefore define the scope of the paleontologic potential in each case. Paleontologists can thus develop maps which suggest sensitive areas and units that are likely to contain paleontological resources. These maps form the bases for preliminary planning decisions. Lead agency evaluation of a project relative to paleontologic sensitivity maps should trigger a “request for opinion” from a state paleontologic clearing house or an accredited institution with an established paleontological repository.

The determination of a site's (or rock unit's) degree of paleontological potential is first founded on a review of pertinent geological and paleontological literature and on locality records of specimens deposited in institutions. This preliminary review may suggest particular areas of known high potential. If an area of high potential cannot be delimited from the literature search and specimen records, a surface survey will determine the fossiliferous potential and extent of the sedimentary units within a specific project. The field survey may extend outside the defined project to areas where rock units are better exposed. If an area is determined to have a high potential for containing paleontologic resources, a program to mitigate impacts is developed. In areas of high sensitivity, a pre-excavation survey prior to excavation is recommended to locate surface concentrations of fossils which might need special salvage methods.

The sensitivity of rock units in which fossils occur may be divided into three operational categories.

A. HIGH POTENTIAL

Rock units from which vertebrate or significant invertebrate fossils or significant suites of plant fossils have been recovered are considered to have a high potential for containing significant non-renewable fossiliferous resources. These units include, but are not limited to, sedimentary formations and some volcanic formations which contain significant nonrenewable paleontologic resources anywhere within their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils. Sensitivity comprises both (a) the potential for yielding abundant or significant vertebrate fossils or for yielding a few significant fossils, large or small, vertebrate, invertebrate, or botanical, and (b) the importance of recovered evidence for new and significant taxonomic, phylogenetic, ecologic, or stratigraphic data. Units which contain potentially datable organic remains older than Recent, including deposits associated with nests or middens, and areas which may contain new vertebrate deposits, traces, or trackways are also classified as significant.

B. UNDETERMINED POTENTIAL

Specific areas underlain by sedimentary rock units for which little information is available are considered to have undetermined fossiliferous potentials. Field surveys by a qualified vertebrate paleontologist to specifically determine the potentials of the rock units are required before programs of impact mitigation for such areas may be developed.

C. LOW POTENTIAL

Reports in the paleontological literature or field surveys by a qualified vertebrate paleontologist may allow determination that some areas or units have low potentials for yielding significant fossils. Such units will be poorly represented by specimens in institutional collections. These deposits generally will not require protection or salvage operations.

MEASURES TO MITIGATE ADVERSE IMPACTS RESULTING FROM DEVELOPMENT

Measures for adequate protection or salvage of significant nonrenewable paleontologic resources are applied to areas determined to have a high potential for containing significant fossils. Specific mitigation measures generally need not be developed for areas of low paleontological potential. Developers and contractors should be made aware, however, that it is necessary to contact a qualified paleontologist if fossils are unearthed in the course of excavation. The paleontologist will then salvage the fossils and assess the necessity for further mitigation measures, if applicable.

A. AREAS OF HIGH POTENTIAL

In areas determined to have a high potential for significant paleontologic resources, an adequate program for mitigating the impact of development should include:

1. a preliminary survey and surface salvage prior to construction;
2. monitoring and salvage during excavation:
3. preparation, including screen washing to recover small specimens (if applicable), and specimen preparation to a point of stabilization and identification;
4. identification, cataloging, curation, and storage; and
5. a final report of the finds and their significance, after all operations are complete.

All phases of mitigation are supervised by a professional paleontologist who maintains the necessary paleontologic collecting permits and repository agreements. The Lead Agency assures compliance with the measures developed to mitigate impacts of excavation during the initial assessment. To assure compliance with the start of the project, a statement that confirms the site's potential sensitivity, confirms the repository agreement with an established institution, and describes the program for impact mitigation, should be deposited with the Lead Agency and contractors before work begins. The program will be reviewed and accepted by the Lead Agency's designated vertebrate paleontologist. If a mitigation program is initiated early during the course of project planning, construction delays due to paleontologic salvage activities can be minimized or avoided.

RECOMMENDED GENERAL GUIDELINES

These guidelines are designed to apply to areas of high paleontologic potential.

A. ASSESSMENT BEFORE CONSTRUCTION STARTS

Preconstruction assessment will develop an adequate program of mitigation. This may include a field survey to delimit the specific boundaries of sensitive areas and pre-excavation meetings with contractors and developers. In some cases it may be necessary to conduct field surveys and/or a salvage program prior to grading to prevent damage to known resources and to avoid delays to construction schedules. Such a program may involve surface collection and/or quarry excavations. A review of the initial assessment and proposed mitigation program by the Lead Agency before operations begin will confirm the adequacy of the proposed program.

B. ADEQUATE MONITORING

An excavation project will retain a qualified project paleontologist. In areas of known high potential, the project paleontologist may designate a paleontologic monitor to be present during 100% of the earth-moving activities. If, after 50% of the grading is completed, it can be demonstrated that the level of monitoring should be reduced, the project paleontologist may so amend the mitigation program.

Paleontologists who monitor excavations must be qualified and experienced in salvaging fossils and authorized to divert equipment temporarily while removing fossils. They should be properly equipped with tools and supplies to allow rapid removal of specimens.

Provision should be made for additional assistants to monitor or help in removing large or abundant fossils to reduce potential delays to excavation schedules. If many pieces of heavy equipment are in use simultaneously but at diverse locations, each location may be individually monitored.

C. MACROFOSSIL SALVAGE

Many specimens recovered from paleontological excavations are easily visible to the eye and large enough to be easily recognized and removed. Some may be fragile and require hardening before moving. Others may require encasing within a plaster jacket for later preparation and conservation in a laboratory. Occasionally specimens encompass all or much of a skeleton and will require moving either as a whole or in blocks for eventual preparation. Such specimens require time to excavate and strengthen before removal and the patience and understanding of the contractor to recover the specimens properly. It is thus important that the contractors and developers are fully aware of the importance and fragility of fossils for their recovery to be undertaken with the optimum chances of successful extraction. The monitor must be empowered to temporarily halt or redirect the excavation equipment away from the fossils to be salvaged.

D. MICROFOSSIL SALVAGE

Many significant vertebrate fossils (e.g., small mammal, bird, reptile, or fish remains) are too small to be visible within the sedimentary matrix. Fine-grained sedimentary horizons and paleosols most often contain such fossils. They are recovered through concentration by screen washing. If the sediments are fossiliferous, bulk samples are taken for later processing to recover any fossils. An adequate sample comprises 12 cubic meters (6,000 lbs or 2,500 kg) of matrix for each site horizon or paleosol, or as determined by the supervising paleontologist. The uniqueness of the recovered fossils may dictate salvage of larger amounts. To avoid construction delays, samples of matrix should be removed from the site and processed elsewhere.

E. PRESERVATION OF SAMPLES

Oriented samples must be preserved for paleomagnetic analysis. Samples of fine matrices should be obtained and stored for pollen analysis. Other matrix samples may be retained with the samples for potential analysis by later workers, for clast source analysis, as a witness to the source rock Unit and possibly for procedures that are not yet envisioned.

F. PREPARATION

Recovered specimens are prepared for identification (not exhibition) and stabilized. Sedimentary matrix with microfossils is screen washed and sorted to identify the contained fossils. Removal of excess matrix during the preparation process reduces storage space.

G. IDENTIFICATION

Specimens are identified by competent qualified specialists to a point of maximum specificity. Ideally, identification is of individual specimens to element, genus, and species. Batch identification and batch numbering (e.g., "mammals, 75 specimens") should be avoided.

H. ANALYSIS

Specimens may be analyzed by stratigraphic occurrence, and by size, taxa, or taphonomic conditions. This results in a faunal list, a stratigraphic distribution of taxa, or evolutionary, ecological, or depositional deductions.

I. STORAGE

Adequate storage in a recognized repository institution for the recovered specimens is an essential goal of the program. Specimens will be cataloged and a complete list will be prepared of specimens introduced into the collections of a repository by the curator of the museum or university. Adequate storage includes curation of individual specimens into the collections of a recognized, nonprofit paleontologic specimen repository with a permanent curator, such as a museum or a university. A complete set of field notes, geologic maps, and stratigraphic sections accompany the fossil collections. Specimens are stored in a fashion that allows retrieval of specific, individual specimens by researchers in the future.

J. SITE PROTECTION

In exceptional instances the process of construction may reveal a fossil occurrence of such importance that salvage or removal is unacceptable to all concerned parties. In such cases, the design concept may be modified to protect and exhibit the occurrence with the project's design, e.g., as an exhibit in a basement mall. Under such circumstances, the site may be declared and dedicated as a protected resource of public value. Associated fragments recovered from such a site will be placed in an approved institutional repository.

K. FINAL REPORT

A report is prepared by the project paleontologist including a summary of the field and laboratory methods, site geology and stratigraphy, faunal list, and a brief statement of the significance and relationship of the site to similar fossil localities. A complete set of field notes, geological maps, stratigraphic sections, and a list of identified specimens accompany the report. The report is finalized only after all aspects of the program are completed. The Final Report together with its accompanying documents constitutes the goals of a mitigation project. Full copies of the Final Report are deposited with the Lead Agency and the repository institution.

L. COMPLIANCE

The Lead Agency assures compliance with measures to protect fossil resources from the beginning of the project by:

1. requesting an assessment and program for impact mitigation which includes salvage and protection during the initial planning phases;
2. by arranging for recovered specimens to be housed in an institutional paleontologic repository; and
3. by requiring the Final Report.

The supervising paleontologist is responsible for:

1. assessment and development of the program for impact mitigation during initial planning phases;
2. the repository agreement;
3. the adequacy and execution of the mitigation measures; and
4. the Final Report.

Acceptance of the Final Report for the project by the Lead Agency signifies completion of the program of mitigation for the project. Review of the Final Report by a vertebrate paleontologist designated by the Lead Agency will establish the effectiveness of the program and adequacy of the report. Inadequate performances in either field comprise noncompliance, and may result in the Lead Agency removing the paleontologist from its list of qualified consultants.

DEFINITIONS

A QUALIFIED VERTEBRATE PALEONTOLOGIST is a practicing scientist who is recognized in the paleontologic community and is proficient in vertebrate paleontology, as demonstrated by:

1. institutional affiliations or appropriate credentials;
2. ability to recognize and recover vertebrate fossils in the field;
3. local geological and biostratigraphic expertise;
4. proficiency in identifying vertebrate fossils; and
5. publications in scientific journals.

A PALEONTOLOGICAL REPOSITORY is a publicly supported, not-for-profit museum or university employing a permanent curator responsible for paleontological records and materials. Such an institution assigns accession and catalog numbers to individual specimens which are stored and conserved to ensure their preservation under adequate security and climate control. The repository will also retain site lists of recovered specimens, and any associated field notes, maps, diagrams, or associated data. It makes its collections of cataloged specimens available to researchers.

SIGNIFICANT NONRENEWABLE PALEONTOLOGIC RESOURCES are fossils and fossiliferous deposits here restricted to vertebrate fossils and their taphonomic and associated environmental indicators. This definition excludes invertebrate or botanical fossils except when present within a given vertebrate assemblage. Certain plant and invertebrate fossils or assemblages may be defined as significant by a project paleontologist, local paleontologist, specialists, or special interest groups, or by Lead Agencies or local governments.

A SIGNIFICANT FOSSILIFEROUS DEPOSIT is a rock Unit or formation which contains significant nonrenewable paleontologic resources, here defined as comprising one or more identifiable vertebrate fossils, large or small, and any associated invertebrate and plant fossils, traces and other data that provide taphonomic, taxonomic, phylogenetic, ecologic, and stratigraphic information (ichnites and trace fossils generated by vertebrate animals, e.g., trackways, or nests and middens which provide datable material and climatic information). Paleontologic resources are considered to be older than recorded history and/or older than 5,000 years BP.

A LEAD AGENCY is the agency responsible for addressing impacts to nonrenewable resources that a specific project might generate.

PALEONTOLOGIC POTENTIAL is the potential for the presence of significant nonrenewable paleontological resources. All sedimentary rocks, some volcanic rocks, and some metamorphic rocks have potential for the presence of significant nonrenewable paleontologic resources. Review of available literature may further refine the potential of each rock unit, formation, or facies.

PALEONTOLOGIC SENSITIVITY is determined only after a field survey of the rock unit in conjunction with a review of available literature and paleontologic locality records. In cases where no subsurface data are available, sensitivity may be determined by subsurface excavations.

APPENDIX B

CONDITIONS OF RECEIVERSHIP FOR PALEONTOLOGICAL SALVAGE COLLECTIONS

CONDITIONS OF RECEIVERSHIP FOR PALEONTOLOGIC SALVAGE COLLECTIONS

Society of Vertebrate Paleontology
Conformable Impact Mitigation Guidelines Committee
Robert E. Reynolds, Chairman

Society of Vertebrate Paleontology News Bulletin Number 166, pages 31-32

February 1996

1. The repository museum and its curator maintain the right to accept or refuse the materials.

2. The materials received must fit with the repository museum's mission and policy statements.

3. All repository arrangements must be made with the curator in advance of receipt. All arrangements for inventory numbers and locality numbers must be made in advance. "Museums are not a dumping ground."

4. The museum will act as the trustee for the specimens. A deed of gift from the land owner or agent must be provided. A loan form or M.O.U. must be prepared for specimens from government lands.

5. Specimens must receive discrete locality numbers. Locality data must be to the maximum specificity available and plotted on 7.5 minute topographic maps, and as specific as allowed by stratigraphic collecting and field mapping. The repository may require the repositor to bear the cost of entering locality data into computerized data files.

6. All reports prepared to meet mitigation requirements, field notes, and photographs must be provided at the time of transfer to the repository museum.

7. Specimens must be delivered to the repository fully prepared and stabilized. Standards of stabilization and modern conservation techniques must be established prior to preparation and must be acceptable to the repository institution. Details of stabilizing materials and chemicals must be provided by the repositor. For microvertebrates, this means sorting and mounting. For large specimens, including whales, this means removal of all unnecessary materials and full stabilization. Fossiliferous matrix must be washed and processed. Earthquake-proofing includes inventory numbers on corks and in vials. In storage, specimens must be insulated or cushioned to protect each from contact or abrasion. Oversized specimens must be stored on shelves or on racks developed to fit existing constraints of the repository museum. The repositor must provide for all nonstandard materials for storage.

8. Specimens must be individually inventoried in accordance with the established system at the repository museum. The specimen inventory must be acceptable to and meet the requirements of the lead agency. Specimens must be identified to element and to maximum reasonable taxonomic specificity. Batch or bulk cataloging must be avoided.

9. Specimens must be cataloged in accord with the repository system so that specimens are retrievable to curators and to researchers. The repository museum may require that the repositor bear the cost of having repository staff catalog specimens into computerized data bases.

10. The repository may require the repositor to bear the cost for completing preparation and stabilization, completing inventory, and completing cataloging.

11. There will be a one-time fee charged by the repository for permanent storage of specimens. This fee will be utilized to compensate the repository for storage space, cabinets or shelves, access or aisle space, a retrievable catalog system, additional preparation, specimen filing, and labor involved in the above. The repository reserves the right to charge the repositor for unpacking and placement of specimens in approved storage cabinets.

APPENDIX C

MAP SHOWING THE LOCATION OF KNOWN FOSSIL LOCALITIES IN THE IMMEDIATE VICINITY OF THE HWY 1 SOQUEL/MORRISSEY AUXILIARY LANES PROJECT

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